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During the period covered by the first year of the award, Souganidis worked on problems related to:

(i) microscopic models for phase transitions and hydrodynamic limits of spin systems,

(ii) turbulent premixed combustion,

and

(iii) kinetic formulation for systems of conservation laws.

A brief description follows of results obtained in each of the above as well as work in progress.

(i) In a joint paper, M. Katsoulakis, who is the ONR postdoc this year, and Souganidis, studied hydrodynamic limits of particle (spin) systems which evolve in time according to Glauber (spin flips) - Kawasaki (simple exchange) dynamics. Such systems are used to describe at the microscopic level phenomena in phase transitions and more specifically the evolution towards the Gibbs measures. The result is that there is a particular scaling such that the scaled system yields (in the mean) a "surface" which moves with normal velocity depending on its mean curvature. This result is global in time, i.e. holds past the first time the geometric evolution develops singularities.

(ii) In a joint work, A. Majda and Souganidis developed simplified effective equations in the simplest prototypical situation involving advection by turbulent velocity fields with two separated scales.

The same paper studies the subtle issues regarding the validity of a Huygens principle for the effective large scale front propagation as well as elementary upper and lower bounds on the velocity. Finally simple examples involving small scale periodic shear layers are also presented. These examples indicate that the above mentioned bounds are sharp. One important consequence of the theory developed in the paper is the rigorous justification of the appropriate renormalized effective large scale front equations for premixed turbulent combustion with two-scale incompressible velocity fields within the thermal-diffusive approximation without any ad hoc approximations.

(iii) Souganidis is working together with B. Perthame and P.-L. Lions towards further understanding already existing kinetic theories for systems of scalar conservation laws as well as towards developing new formulations in more general multidimensional problems. The work so far has concentrated on the first of the above. In this case the emphasis is on obtaining new estimates, which in turn will yield improved and new compactness results. The investigation so far has lead to a number of preliminary but rather encouraging results.